THE CENTER FOR ASTHMA AND ENVIRONMENTAL EXPOSURE

"Linking research to public policy:"

Long term goal of the Center is to become a center of excellence in environmental health research - with emphasis on respiratory health especially disease prevention at a community level. This will be accomplished through linking research to policy decisions.

Mission of the Center:

Conduct research on asthma and other respiratory diseased related to environment.

Communicate research findings to communities (grassroots) and their leaders.

Work with communities and their leaders to implement policies that incorporate research findings.

Is Asthma An Ultrafine Particle Disease? – A Hypothesis
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NEW!

Is Asthma An Ultrafine Particle Disease? – A Hypothesis

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Background

The exact causes of asthma are unknown. Genetic risk factors are important. However, they do not explain the increase in the number of persons with asthma in the United States, from 6.8 million persons in 1980 to about 15 million in 1996. Changes in genetic composition of the population would occur more slowly. Identical twin studies suggest that genetic factors explain only 20% of cases of asthma; the remaining 80% is attributed to environmental factors. Some chemicals in the workplace

can cause asthma. Some researchers have explained the increase in asthma prevalence as due to changes in childhood exposures to certain infections or lack thereof, that result in immunological reactions which favor allergic responses and asthma. Other studies have found maternal nursing for the first six months protective against childhood asthma. Living in close proximity (within 75 m) of busy roadways has been associated with increased asthma risk. However, this would not explain the occurrence of asthma in cases further away from busy roadways. The above hypotheses provide partial explanations to the diverse occurrence of asthma. For unclear reasons, asthma rates are particularly high among certain population groups such as persons of Puerto Rican heritage who reside on mainland US.

The current hypothesis

Chronic exposure to high concentrations of ultrafine particles that are generated indoors by electric, gas stoves, ovens and other kitchen appliances in poorly ventilated homes contributes not only to flare-ups of asthma but also to the development of asthma. In other words, asthma is an ultrafine particle disease.

Discussion

The above hypothesis is supported by the recent report from the National Institute of Standards and Technology that found that nanoparticles are released by common kitchen appliances. In 150 experiments, the investigators found that gas and electric stoves and electric toaster ovens release nanoparticles. Electrical heating elements and wires most commonly consist of an alloy of nickel (80%) and chromium (20%). During the first burn, new heating elements or wires form stable protective oxide layers that in theory prevent further oxidation of the heating elements. However, recent studies using nanobeam X-ray and magnetic force microscopy have found that such protective oxide layers actually consists of a mixture of oxide materials and metal nanoparticles. It is plausible that during heating, metal nanoparticles "escape" from the metal nanonetworks. I speculate that at least in the case of electrical heating elements some of the ultrafine particulates contain nickel or chromium. Recently, Italian scientists reported that nanoparticles were produced by natural gas domestic burners. Thus, electric and gas burners in homes kitchen appliances produce ultrafine particles that cause airway inflammation during normal use.

Recognizing and highlighting of asthma as an ultrafine particle disease opens new approaches and thinking about asthma as well as prevention of other inflammatory diseases of the lung. First, it maintains the centrality of airway inflammation in the initiation and maintenance of asthma symptoms. Second, it fits well with other factors such as genetics, allergen exposure, and other factors that have been observed to contribute to increased asthma incidence but do not completely explain the observed disease patterns. Third, it provides a framework that can explain the increase in asthma prevalence which occurred

during the period when there were changes in housing construction were made to conserve energy and there was worldwide urbanization. In order to save energy, some individuals in cold climates sealed their windows with plastic. Many homes have cooking stoves that are not vented outside and in some cases stove fans are used sparingly or not at all. Investigators at the Center for Asthma and Environmental Exposure have found that people who live in close proximity to busy roadways often complain of dust and as a result keep windows closed in order to keep the dust out; as a result they actually seal particulates inside their homes. Fourth, the hypothesis may explain the high asthma rates observed among persons of Puerto Rican heritage who live in mainland US who use the cooking stove throughout the day. Fifth, it would explain the higher occurrence of asthma and chronic respiratory symptoms among women compared to men since in most families women do the cooking. Sixth, the apparent improvement in asthma symptoms as some children grow up could be explained in part by the fact that the children may be spending less time in homes that have high ultrafine particle concentrations. Finally, recognizing the potential role of particulates in the initiation of asthma and in causing asthma flare-ups provides new preventive opportunities for patients that continue to have symptoms despite maximal medical regimens.

In the US and other developed countries individuals spend 90% of their time indoors. Ultrafine particles are produced when electrical heating elements or gas burners are turned on. The particulates reach concentrations that are five to ten times the concentrations that are measured at the roadside of busy truck routes. Ultrafine particles (20 nm – 500 μm diameter) once generated, remain elevated for over three hours after the burners are turned off. The heating element by itself, without the addition of food, generates ultrafine particles. The concentration of particulates generated increases with the intensity of the heat of the heating element. Food being cooked generates additional particulates and volatile organic compounds that can be measured. In addition, cooking with gas stoves may release nitric oxide that is converted into nitrogen dioxide which is an airway irritant. Thus, a family that cooks three meals a day or uses a cooking stove continually through the day, is chronically exposed to high levels of ultrafine particles. Previous studies showed that ultrafine particles cause lung inflammation with no apparent concentration threshold. The research has further shown that the particulates can enter blood circulation and exert effects on distant organs which has implications for diseases beyond asthma.

In developing the above hypothesis I considered focusing on nanoparticles. Nanoparticles are particulates with at least one diameter measuring =100 nanometers. However, I observed that when electric or gas stoves are turned on in a home, numerous particles ranging in size from 20nm to 500nm are generated and remain suspended for the long periods of time described above. In contrast, particles that measure 1.0 μm to 10 μm in diameter are less numerous, sediment rapidly from the air and are more sensitive to human activity (movement). For this

reason I have elected to use the term ultrafine particles which would include nanoparticles as well as particulates up to 500 nm.

In warm rural climates cooking is often done in the open. Hence, indoor particulate concentrations more closely mirror those found outside. Asthma rates tend to be low in rural communities. However, in cold climates or urbanized environments cooking is done inside the homes in closed environments that are often not vented outside. In addition, gas stoves may be associated with exposure to nitric oxide. In some cases, residents may block vents to conserve heat during the cold months, or may not run the exhaust fan at all. Previous research has focused on exposures to ultrafine particles that occur in the work place, in laboratories and in ambient air as with traffic related pollution. As the above discussion shows a much greater exposure to high concentrations of ultrafine particles occurring in people's homes than previously realized and may be contributing to diverse illnesses including asthma.

Implications

1. Asthma prevented by removing causes airway inflammation rather than focusing on controlling already established inflammation.
2. Improve ventilation of cooking areas and make sure that cooking ranges are vented outside.
3. Research is needed to develop heating elements that do not generate ultrafine particles when turned on – for example imbedding electrical burners in silicon could decrease "escape "of metal nanoparticles during heating.
4. Implement a consumer-driven rating of kitchen appliances to inform users of releases of particulates during use of the appliances.
5. When increasing ventilation is not be feasible, for example in homes that are located close to busy roadways where outside air is already contaminated, home air filtration is an effective method of particulate removal. However the air filtration system used should not add pollutants such as ozone to the indoor air.
6. Environmental impacts on asthma need to be re-evaluated to include home generated ultrafine particles as contributors to asthma, COPD, cardiovascular and other disorders.
7. Since the lungs are continually exposed to indoor generated ultrafine particles, exposure to ultrafine particles should be considered in unexplained inflammatory disorders of the lung.
8. Because of the very large volume of air we breathe in each day, lungs should be considered as important entry points for ultrafine particles that impact other organs.
9. It is important to also note that particulates may enter the brain through olfactory tracts which has implications for neurodegenerative disorders.

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